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Traveling Salesman Problem Using Genetic Algorithm: A Survey

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ABSTRACT

Traveling Salesman Problem is a well-known NP-Complete problem in computer science. It has many application areas in science and engineering. It is an optimization problem. TSP can be solved using heuristic techniques such as genetic algorithm. This paper gives a brief survey of various existing techniques for solving TSP using Genetic Algorithm. The paper compares the advantages and disadvantages of various algorithms for solving TSP using GA. The paper compares the performance of various algorithms to solve TSP and also suggest some future directions for research to motivate new researchers in this field.

Keywords: Traveling Salesman Problem, Genetic Algorithm, Cross Over, Mutation

I. INTRODUCTION

The Traveling Salesman Problem is an optimization problem in which a salesman has to visit a given set of cities. All the cities can be represented using a fully connected graph. Salesman starts his journey from one city and then it travel each and every city by following constraints

- ✓ Salesman has to visit each and every city exactly once without repeating any city.
- ✓ Salesman completes its journey at the starting city.
- ✓ The distance travelled by the salesman to visit all cities should be minimum.

The time complexity of the algorithm to find such a tour increases, as the number of cities increases. Since the number of cities are very large the complexity to find the optimum tour is n!. So the problem becomes not solvable in limited time. In literature many meta-heuristic techniques such as Genetic Algorithm GA, Particle Swarm Optimization PSO, Ant Colony Optimization ACO are used to solve TSP. In this paper a brief survey of various techniques for solving TSP using GA is given.

Genetic Algorithm is an optimization algorithm that can be used to solve both minimization and maximization problem. GA depends upon its genetic operators such as selection, reproduction and mutation to solve any optimization problem. TSP is a minimization problem in which we have to find a route with minimum distance to visit all the cities. Genetic algorithm starts with an initial population of chromosomes. A chromosome represents a solution of the problem. Chromosomes are generated randomly when the problem is represented in genetic form. Then a bunch of chromosomes is selected from the initial population by using selection operator. This bunch of chromosomes participates in reproduction operation to generate new children. These newly generated children are added in the initial population and then mutation operation is performed to generate the next population. These operations i.e. selection, reproduction and cross over are repeated again and again for a given number of iteration count or till an optimal solution is not found. Next section presents a survey of various techniques to solve TSP using Genetic Algorithm.

II. REVIEW ON GENETIC ALGORITHM

Oliviu Matei [1] proposed the solution for the Generalized Traveling Salesman Problem GTSP. GTSP has many application areas in science and engineering. In this paper author used a local- global technique to solve Generalized Traveling Salesman Problem. Author proposed an efficient Genetic Algorithm to solve GTSP. The proposed algorithm use the techniques of local and global connections by considering nodes sets (clusters) and find a minimum

distance by including exactly one node from each cluster. Author simulates the problem on various TSP instances for TSPLIB and compared the result of proposed algorithm with some other existing algorithms.

Gohar Vahdati et al. [2] proposed a hybrid search algorithm with Hopfield neural network (HNN) and Genetic algorithm (GA). The proposed algorithm has both the advantages of HNN and GA that can explore the search space and exploit the best solution. HNN is a very nice and efficient technique to solve TSP. Experimental results demonstrate that the proposed algorithm does not get stuck at a local optimum. This paper uses Hopfield neural network in solving TSP. The HNN generate a initial population of valid solutions and then HNNGA find better solutions as compared to other Genetic Algorithms.

Yang Yi and Qian-sheng Fang [3] propose a solution for Traveling Salesman Problem (TSP). The valid and optimal solution of TSP can be used in many areas of engineering. This paper used Handle-C language to find improved and hybrid genetic algorithm to solve TSP. Author implemented the proposed handle C technique on various TSPLIB instances and found that the proposed algorithm outperforms as compared to some other existing algorithms. The improved Genetic Algorithm uses a stronger global search technique that gives higher rate of convergence of Genetic Algorithm. It means the algorithm find tour with less path length in less time as compared to other existing algorithms.

Musheer Ahmad et.al. [4] Proposed efficient cryptographic substitution box design using traveling salesman problem and chaos. The Chao cryptography is used by many researchers and scientists in finding solution of various mathematical, scientific and engineering problems. Chao uses many security primitives for generating initial conditions. It uses pseudo-random and long periodic and high periodicity. It is extremely is in text, image, video and audio encryption, hash functions and data hiding techniques. The paper proposes to present novel approach to synthesis efficient S-box using traveling salesman problem and PWLCM chaotic map.

Yuxin Liu, Chao Gao, Zili Zhang, Yuxiao Lu, Shi Chen, Mingxin Liang, and Li Tao [5] proposed solution of NP-Hard Problems with Physarum-Based Ant Colony System. ACO provide solutions for various NP problems such as TSP, Knapsack etc. The main disadvantages of ACO are premature convergence and weak robustness. The optimized updating strategy of this paper provides unique technique and it accelerates the feedback process of ACO. This technique provides a faster convergence. The experimental results show that the proposed ACO performs the other Meta heuristic techniques to solve TSP. Physarum-inspired mathematical Model PMM can also be used in solving other NPC (NP-Complete) and NPH (NP-Hard) problems.

K. Bharathi and C. Vijayalakshmi [6] deal with the design of an evolutionary algorithm for a Multi Travelling Salesman problem. The aim of this paper s to find an efficient evolutionary technique for MTSP Multi Travelling Salesman problem. IN MTSP there are multiple objectives in the TSP problem. The evolutionary approaches have been represented in multi ways as Genetic Algorithm, Genetic Programming, Evolutionary Strategies, Evolutionary Programming, and so on.

Rishita Kalyani [7] deal with a combination of Ant Colony and Genetic Programming Algorithm to optimize Travelling Salesmen problem. The author use parallel implementation of the problem to reduce time to solve TSP. The paper presents a solution of TSP using GA which is implemented on Multi-Core processors systems. The Multi-core parallelization to the TSP problem is found using OPENMP library by Intel Corporation. Author concludes that ACO and GA can also be merged with PSO Particle Swarm Optimization algorithm to get better results.

Ghorbanali Mohammadi [8] provides a study on genetic algorithms to solve industrial time-cost trade-off problems. Paper [8] presents a Multi-Objective Genetic Algorithm (MOGA) approach to time-cost trade-off problems (TCTP). Finding optimal decisions is difficult and time-consuming considering the numbers of permutations involved. This type of problem is NP-hard, hence attainment of IP/LP solutions, or solutions via Total Enumeration (TE) is computationally prohibitive.

Bao Lin1 Xiaoyan Sun and Sana Salous [9] proposed a novel heuristic HGA integrating GA and the local search method. The algorithm combines the two techniques in a good symbiotic behavior and proposed

and illustrated for the two-dimensional symmetric Euclidean TSP. The proposed technique compensate between global and local search and find a better algorithm to solve TSP. Experimental results illustrates that the proposed HGA outperforms some other existing algorithm to solve TSP.

III. COMPARATIVE STUDY OF RESULTS FOUND USING VARIOUS ALGORITHMS

This paper presents a review on various techniques to solve TSP using Genetic Algorithms. From the detail literature survey it has been concluded that the performance of solving TSP using GA varies differently. The performance of GA mainly depend on its operators and the performance of an operator improves and affect the performance of the whole GA. Table-1 shows a critical analysis of performance of various results in solving TSP using GA.

Table-1 Critical analysis of performance of various

TSP Instance (Optimal)	Best Solution using HGA [9]		HNNGA [2]	
	Best Solution	Average Solution	Best Solution	Average Solution
Eil51(426)	436	440	429	434
Eil76(538)	552	559	549	556
Eil101(629)	651	661	NA	NA
Pr107(44303)	44661	45150	NA	NA
Pr124(59030)	59452	57784	NA	NA

From Table-1 it can be found that the performance of GA can be improved using some hybridization techniques such as HGA and HNNGA.

IV. CONCLUSION

This paper presents a glance of various approaches being used to solve TSP. Genetic algorithms depends very much on the manner the problem is fixed and which crossover and mutation methods are used. It works according to that and discover good solutions for the TSP. A number of genetic algorithm techniques have been analyzed and surveyed for solving TSP. Combining the knowledge from heuristic methods and genetic algorithms is a hopeful approach for solving the TSP. Although all the algorithms have their individual identity and produce solutions according to that, combining two or more algorithms will lead us to reach a best prominent and optimal solution for TSP.

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